M. Sc. Wine, Brewing and Alcohol Technology Course
(Affiliated to University of Pune)

Eligibility:

B. Sc. in Wine Technology/ Post Graduate Diploma in Industrial Fermentation and Alcohol Technology/ B.Sc. in Bio-Technology/ Microbiology/ Chemistry/ Agriculture/ Botany/ Zoology/ and B.E. /B. Tech. (Chemical Engineering/ Biotechnology)
M. Sc. (WBAT) Revised Syllabus

University of Pune
Proposed Revised Syllabus for
M. Sc. Wine, Brewing and Alcohol Technology Course
(Based on Choice Based Credit System)

Course Structure

1. There will be FIVE courses in each semester.
2. Each course will be of 100 marks and 75 lectures.
3. Practical course will be of 24 practical having each practical is of 4 hours.

M. Sc. Part – I
Semester-I

WT 1.1 Viticulture
WT 1.2 Microbiology of Alcohol, Beer and Wine
WT 1.3 Biochemistry of Alcohol, Beer and Wine
WT 1.4 Practical-I
WT 1.5 Practical- II

Semester-II

WT 2.1 Alcohol Technology-I
WT 2.2 Brewing Technology-I
WT 2.3 Enology-I
WT 2.4 Chemical and Plant Engineering-I
WT 2.5 Practical- I

Semester-III

WT 3.1 Alcohol Technology –II
WT 3.2 Brewing Technology-II
WT 3.3 Enology-II
WT 3.4 Chemical and Plant Engineering-II
WT 3.5 Practical- I

Semester-IV

WT 4.1 Business Management
WT 4.2 Industrial waste treatment & Environmental management
WT 4.3 Alcohol Technology –III
WT 4.41 Second Generation Biofuels
WT 4.42 Advance Brewing Technology
WT 4.43 Advance Enology
WT 4.5 Project work (Which will be of individuals/groups/Inplant training)
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M. Sc. - I
Semester-I
WT 1.1 Viticulture
Summary

<table>
<thead>
<tr>
<th>Credit No.</th>
<th>Credit title</th>
<th>Number of teaching clock hours per credit</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.01 TC</td>
<td>The grapevine and its varieties</td>
<td>15</td>
</tr>
<tr>
<td>1.02 TC</td>
<td>Vine pests &amp; diseases</td>
<td>15</td>
</tr>
<tr>
<td>1.03 TC</td>
<td>The vine and role of climatic factors on harvesting of grapes</td>
<td>15</td>
</tr>
<tr>
<td>1.04 TN</td>
<td>World scenario of grapes</td>
<td>15</td>
</tr>
<tr>
<td>1.05 TN</td>
<td>Biotechnological tools to access genetic purity and diversity</td>
<td>15</td>
</tr>
<tr>
<td>1.06 TN</td>
<td>Soil for cultivation of grape vine</td>
<td>15</td>
</tr>
</tbody>
</table>

Total: 75+15=90 clock hours

Note:
1) 3 TC Credits and any 2 Credits from TN.
2) The subject covers total 5 Credits i.e.
   Teaching clock hours = 60 clock hours and
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WT 1.1 Viticulture

1.01 TC: The grapevine and its varieties,
Terroir: The qualities of the soil; Destroyed at the root? Mechanization in the vineyard. Varieties of grapes; the most important white wine grape Varieties; The most important Red wine grape Varieties, Vine cultivation: Pruning the vines; Methods of cultivation; Integrated Pest management.

1.02 TC: Vine pests & diseases
Serious Vine diseases; Some feared Vineyard pests; Phylloxera; Bacterial diseases of the Grapevine- Pierce's disease, Crown Gall; Viral diseases of the Grapevine- Fan leaf degeneration; Grapevine Leaf roll; Fungal diseases of the Grapevine- Dowery Mildew, Powdery Mildew, Black rot, Dead-arm, Anthrac nose, Pierce’s diseases, Crown Gall. Sanitary and phytosanitary measures of wine grapes

1.03 TC: The vine and Role of climatic factors on harvesting of grapes.
The origin, taxonomy and Biogeography of the grapevine- Prehistoric evidence for vitis, differences between muscadine grapes & Evatis species; The grape and maturation processes- Berry structure, Development stages of the grape, Flavor and aroma compounds in the mature grape, grape derived phenolic compounds. The working years in the vineyard- Care of the soil & more; Grape ripeness;
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1.04  **TN: World scenario of grapes**
Grape producing countries, topmost grape and wine producing countries in world, Grape production scenario of India and major states in India. Statistical data of grape production global and Indian scenario.

1.05  **TN: Biotechnological tools to access genetic purity and diversity.**
Applications of genetical control mechanism in grapes development. Development of grape varieties resistant to various biotic and abiotic stresses.

1.06  **TN: Soil for cultivation of grape vine**

**Reference Books:**

1. American Society for Enology and Viticulture- Seattle.
2. Diseases and pests- Phil Nicholas, Peter Magarey, Malcom Wachtel.
9. Introduction to wine making – Viticulture and Enology 3- Prof. Ralph E. Kunkee.
10. Biology of microorganisms on grapes, in must and in wine- Konig Helmut.
WT 1.2 Microbiology of Alcohol, Beer and Wine

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<td>Classification of microorganisms, staining techniques and cell biology</td>
<td>15</td>
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<td>2.02 TC</td>
<td>Basic techniques in Microbiology</td>
<td>15</td>
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<tr>
<td>2.03 TC</td>
<td>Microbiology of yeast</td>
<td>15</td>
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<tr>
<td>2.04 TN</td>
<td>Solid state fermentation</td>
<td>15</td>
</tr>
<tr>
<td>2.05 TN</td>
<td>Contamination control in alcoholic fermentations</td>
<td>15</td>
</tr>
<tr>
<td>2.06 TN</td>
<td>Industrially important fermentation products</td>
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2.01 TC: Classification of microorganisms, staining techniques and Cell biology:

2.02 TC: Basic techniques in microbiology

2.03 TC: Microbiology of yeast
Definition, comparison with other microorganisms, yeast morphology and taxonomy, yeast cell structure and functions of various cellular components. Nutritional requirements of yeast, Aerobic and anaerobic metabolic pathways in
M. Sc. (WBAT) Revised Syllabus

yeast for sugar dissimilation, Isolation and Maintenance of yeast, Staichiometry of alcohol production.

2.04 TN: Solid state fermentation
Comparison of solid state fermentation with other types of fermentations, Importance of solid state fermentation, the industrial production of various SSF based products.

2.05 TN: Contamination control in alcoholic fermentations
Introduction to antibiotics, Mechanism of various antibiotics, Effect of microbial contaminants on alcoholic fermentations. Role of antimicrobial substances controlling contamination in alcoholic fermentation,

2.06 TN: Industrially important fermentation products
Role of fungi in various fermentations, Examples of various fermentations using yeast with special reference to Glycerol, baker’s yeast, etc.

Reference Books:
1. The microbial world – Stainer
2. General Microbiology – Volume I and II Power and Daginwala
3. Elements of Microbiology – Pelczar
4. Principles of Microbiology – Sanyogita Wadikar
5. Microbial Technology – Papler Vol. I and II
6. Industrial Microbiology – Casida
8. Production wine analysis- Zoecklein B. W.
9. The yeast- Lodder H. J.
11. Wine and beverage- Bell D. A.
WT 1.3 Biochemistry of Alcohol, Beer and Wine

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<td>Biochemistry of living cells</td>
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<tr>
<td>3.02 TC</td>
<td>Proteins, carbohydrates and lipids</td>
<td>15</td>
</tr>
<tr>
<td>3.03 TC</td>
<td>Biochemistry of alcoholic fermentation</td>
<td>15</td>
</tr>
<tr>
<td>3.04 TN</td>
<td>Protein Synthesis</td>
<td>15</td>
</tr>
<tr>
<td>3.05 TN</td>
<td>DNA and chromosomes</td>
<td>15</td>
</tr>
<tr>
<td>3.06 TN</td>
<td>Production of biogenic amines &amp; ethyl carbamate</td>
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75+15=90

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3.01 TC: Biochemistry of living cells
Classification of living cells, structure and function of cells DNA/RNA and protein synthesis. Photosynthesis: Definition, importance and mechanism, light reaction, Dark reactions and factors affecting the photosynthesis rate.

3.02 TC: Proteins, carbohydrates and lipids
Characteristics and classification of proteins, protein structure and proteins in sugarcane juice. Amino Acids: Classification and properties, amino acids in sugarcane juice and molasses. Classification of carbohydrates, Examples and structures of various carbohydrates, Important carbohydrates for production of alcohol, beer and wine. Glycolysis, TCA cycle, Pentose Phosphate pathway, Glyoxylate cycle, Metabolism of amino acids. Definition, nomenclature, classification - (simple, complex, derived lipids - structure & example) phospholipids, glycolipids, - (structure, composition).

3.03 TC: Biochemistry of alcoholic fermentation
Pathways involved in alcoholic fermentation, Transport of carbohydrates in yeast. Inter relationship between sugar uptake during alcoholic fermentation (Pasteur and Crabtree Effect).

3.04 TN: Protein Synthesis
Definition, Structure of protein, Classification (Primary, Secondary, Tertiary, Quaternary- definition, examples) Types and functions of proteins, Biological importance, mechanism of protein synthesis.

3.05 TN: DNA and Chromosomes
DNA as the molecule of information: DNA as the genetic material and its organization. DNA structure, Purine, pyrimidine - definition and structure. Nucleoside, nucleotide: definition and structure. Chemical Properties: Hydrolysis
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(acid, alkali), enzymatic hydrolysis of DNA. DNA replication and it’s regulation. DNA damage and repair. Chromosomes: Structure and shapes of metaphase chromosomes histone, non histone proteins Nucleosome and packing of DNA into chromosome.

3.06 TN: Production of biogenic amines & ethyl carbamate
Usage & formation of sulphur compound. Microbial formation & modification of flavor & off-flavor compounds in wine. Exoenzymes of wine microorganisms.

Reference Books:
1. Biochemistry –Lehninger
2. Biochemistry – West and Todd
5. Chemical analysis of grapes and wine techniques and concepts- Patrick ILAND, Nick BRUER, Andrew EWART, Andrew MARKIDES, John SITTERS.

WT 1.4 Practical-I
1. Morphological and anatomical studies of grapevines and sugar canes varities and to note differences —3P
2. Field practicals on cultivation practices of grapevine and sugar canes such as pruning, grafting, spacing etc ----2P
3. Illustrated field exercises for harvesting and handling of grapevines –1P
4. Soil analysis : pH, temperature, soil texture, porosity, NPK, organic carbon, salinity, EC, soil moisture. (4P)
5. To collect infected samples and study the morphology of major pest and their life cycle 4P
6. Water Analysis: pH, alkalinity, hardness, chlorites EC, nutrients (3P)
7. Determination of Brix, Specific Gravity, pH of molasses
8. Determination of moisture and ash content of molasses.
9. Determination of total solids and suspended solids of molasses.
10. Determination the reducing sugar in final molasses.
11. Determination the total reducing sugar in final molasses.
12. Estimation of calcium content of molasses by EDTA method.

WT 1.5 practical-II
1. Preparation of culture media & sterilization.
3. Preparation of MGYP & molasses medium slants.
4. Enumeration of microorganisms by four-quadrant method.
5. Enumeration of microorganisms by using spread plate technique.
6. Counting of microorganisms by pour plate method.
7. Preparation of slide culture of yeast.
8. Negative staining and monochrome staining and Gram staining.
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11. Determination of alcohol content by spectroscopic method.
12. Estimation of enzyme activities such as amalyse, glucoamylase (3P)
13. Estimation of proteins by Biuret and Lawry method (2P)
14. Determination of ethyl alcohol content of spirit by specific gravity method.
15. To determine the total sugars as invert sugars in final molasses.
17. Determination of total organic volatile acids of fermentation broth sample
Semester –II
WT 2.1 Alcohol Technology – I
Summary

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<tr>
<td>2.01 TC</td>
<td>Yeast maintenance and propagation in distillery</td>
<td>15</td>
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<tr>
<td>2.02 TC</td>
<td>Raw material for alcoholic Fermentation</td>
<td>15</td>
</tr>
<tr>
<td>2.03 TC</td>
<td>Details of alcoholic fermentation</td>
<td>15</td>
</tr>
<tr>
<td>2.04 TN</td>
<td>Chemistry of alcohol</td>
<td>15</td>
</tr>
<tr>
<td>2.05 TN</td>
<td>Alcohol based chemicals</td>
<td>15</td>
</tr>
<tr>
<td>2.06 TN</td>
<td>Manufacturing of alcohol from various substrates</td>
<td>15</td>
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2.01 TC: Yeast maintenance and propagation in distillery
Design of yeast vessels, material of construction and its maintenance. Propagation practices of yeast adopted under plant conditions. Measurement of number of yeast cells/yeast count etc. Use of Bakers yeast. Active Dry yeast and yeast Acidification / pretreatment practices. Pre-fermentation practices adopted for yeast propagation prior to inoculation to main fermenter. Prefermenter (Blue) design; material of construction and its maintenance. Use of sterile air/sparging system in Prefermenter.

2.02 TC: Raw material for alcoholic fermentation
Overview of Molasses composition, grades, storage and cost. Details of molasses weighing system. Molasses dilution practices adopted and design of diluter, quality of dilution water used, Quality of water and molasses dilution practices. Pre clarification of molasses advantages and drawback, molasses sterilization/pasteurization.

2.03 TC: Details of alcoholic fermentation
Process of Batch fermentation, factor influencing efficiency of fermentation, characteristics of Batch Fermentation Process, Control over fermentation operation, contamination control, design and material of construction of fermenters, maintenance of fermenter and operational conditions on plant scale, flow sheet of Batch Fermentation process, Efficiency of Fermentation and Attenuation data calculations – Related examples and solutions. Alcoholmetry – proof spirit (British and USA) over proof, under proof, specific gravity of alcohol strength of alcohol in terms of concentration – related examples and solution. Prevention of losses of alcohol during fermentation, post – fermentation practices/scrubbing etc.
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2.04 TN: Chemistry of alcohol
What is alcohol? Physical and chemical properties of alcohol; Classification of alcohols, Important chemical reactions of alcohol; Production of alcohol by synthetic method. Uses of alcohol.

2.05 TN: Alcohol based chemicals
Detail study of reactions involved, manufacturing process, uses, list of manufacturers-Acetaldehyde, Acetic acid, Acetic-Anhydride, Butanol, Ethyl acetate, Butyl acetate, acetone, Ethyl ether, Diethyl oxalate.

2.06 TN: Manufacturing of alcohol from various substrates
Introduction to various substrates used for alcohol production. Details of alcohol yield using sugarcane and sugar beet molasses, rice, maize, sorghum, bajara, wheat, dates, cashew apple, etc.

Reference Books:

2. Alcoholometry – Satyanarayana Rao
3. Handbook of Fermentation and Distillation – A.C. Chatterjee
4. Distillation – H. C. Barron
5. Technical Excise Manual
6. Byproducts of Sugar Industry – Paturao
WT 2.2 Brewing Technology-I
Summary

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<tr>
<td>2.01 TC</td>
<td>History and overview of Industrial Brewing</td>
<td>15</td>
</tr>
<tr>
<td>2.02 TC</td>
<td>Beer origin, classification and beer styles</td>
<td>15</td>
</tr>
<tr>
<td>2.03 TC</td>
<td>Basic raw materials of brewing</td>
<td>15</td>
</tr>
<tr>
<td>2.04 TN</td>
<td>Overview of world and Indian brewing scenario</td>
<td>15</td>
</tr>
<tr>
<td>2.05 TN</td>
<td>Hop products</td>
<td>15</td>
</tr>
<tr>
<td>2.06 TN</td>
<td>Alcoholism</td>
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</tr>
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2.01 TC: History and overview of Industrial Brewing

2.02 TC: Beer origin, classification and beer styles

2.03 C: Basic raw materials of brewing
Water: Water usage in the Brewery, Brewery water consumption, Brwery water Calgary’s: Brewing water, process water, General-purpose water, service water, water standards for ingredient use. Chemical Characterization of water types, Microbial constituents of water, the influence of inorganic ions from water on Beer Quality, ingredient effect of ions on Beer flavor and quality, control of pH, water treatment systems.
Barley and Malt: - Barley – Structure and function, the husk the pericarp, testa, Aleurone Layer, Starchy Endosperm, The Embryo.
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Malt Production, Drying, Storage, and Handling, steeping, Germination, Kilning and Malt Quality, Malt varieties.
Adjuncts: Introduction, Corn Grits, Rice, Barley, Sorghum, Refined Corn Starch, wheat starch, Terrified cereals, liquid adjuncts, Malt from cereals other than Barley. Wheat Malt, Oats and Rye Malt, Sorghum, Conclusions.
Hops: Hop Growing, History, Hop Growing today, the hop plant, Hop classification, Hop cultivation, Harvesting, drying and packing, Hop varieties.

2.04 TN: Overview of world and Indian brewing scenario
Global brewing scenario, Major beer manufacturing companies in the world and major brands. Statistics of production and per capita consumption of beer in various countries. Indian brewing scenario and scope for brewing industry in India.

2.05 TN: Hop products

2.06TN: Alcoholism
What is alcoholism? Effects of alcohol on human being-Health issues, social issues and economical issues. Concept of responsible drinking. Alcohol unit, measurement of alcohol units in various alcoholic beverages.

Reference Book:
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WT 2.3 Enology-I
Summary

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<td>3.01 TC</td>
<td>History and classification of wine</td>
<td>15</td>
</tr>
<tr>
<td>3.02 TC</td>
<td>Wine making processes</td>
<td>15</td>
</tr>
<tr>
<td>3.03 TC</td>
<td>Clarification, stabilization, preservation, maturation and fortification of wine</td>
<td>15</td>
</tr>
<tr>
<td>3.04 TN</td>
<td>Overview of world and Indian wine scenario</td>
<td>15</td>
</tr>
<tr>
<td>3.05 TN</td>
<td>Nutritional and health aspects of Wine</td>
<td>15</td>
</tr>
<tr>
<td>3.06 TN</td>
<td>Pot distillation of wine</td>
<td>15</td>
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1.01 TC: History and classification of wine
Introduction: History of wine making, present international and national status of wine production and wine market, scope and importance of wine industries, nutritional and therapeutic value of wine, commercial aspect of wine production. Classification of wine- table wines, sparkling wine, dessert wines, aperitif wine, pop wine.

1.02 TC: Wine making processes
Red wine production-time of harvest, harvesting, crushing & fermentation, blending; White wine production- White wine styles, harvesting, crushing, pressing, settling/clarification & fermentation. Manufacturing of fruit wine from pomegranate, banana, jamun, etc. Manufacturing of apple, pear ciders, Sparkling wine- The Champagne method, the tank method, the transfer method, carbonation; cold maceration; carbonic maceration; thermo vinification; chaptalisation; use of commercial enzyme in wine making. Monitoring and controlling of fermentation parameters of wine: monitoring and viability and cell number of yeast during must preparation, controlling microbial growth during wine production, effect of pH, temperature, CO₂, amount of sugar consumed. Use of Destemer/crusher, Pneumatic press, Fermenter, Cooling system, Kielsgur filter, Seitz filter, Cold stabilizer, Bottling machine and neck freezing machine.

1.03 TC: Clarification, stabilization, preservation, maturation and fortification of wine
Clarification & stabilization of wine- Clarification- proteins, polyvinyl polypyrrolidone & bentonite; Tartaric acid, tartarate & wine stability- static cold stabilization, contact cold stabilization, ion exchange stabilization, estimation of cold stability, prevention of crystalisation, protein instability, assessment of heat
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1.04 TN: Overview of world and Indian wine scenario
New concept of wine production: organic, biodynamic wine, Ice wine, etc. Major wine producing countries in the world, Per capita consumption and production statistics of wine production of major top wine manufacturing countries in the world. The current and future wine prospectus in India.

1.05 TN: Nutritional and health aspects of wine
Chemical contents of grapes and wine in relation to nutrition, Contribution of important chemicals at human health point of view, List of diseases cured by wine, Role of antioxidants of wine on human health. Comparison of Red, white and sparkling wine at nutritional point of view.

1.06 TN: Pot distillation of wine
Details of pot distillation, Manufacturing and maturation of grape spirit, Production of brandy, Cognac, Legal attributes of production and marketing of Cognac.

Reference Book:
4. Introduction to winemaking, Viticulture and Enology 3- Prof. Ralph E. Kunkee.
5. Understanding wine- Course notes- Patrick Iland, Peter Gago.
10. Monitoring the wine making process from grapes to win techniques and concepts- Patrick ILAND, Nick BRUER, Andrew EWART, Andrew MARKIDES, John SITTERS.
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WT 2.4 Chemical and Plant Engineering-I

Summary

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<td>4.01 TC</td>
<td>Principles of distillation</td>
<td>15</td>
</tr>
<tr>
<td>4.02 TC</td>
<td>Utility requirements for typical distillery</td>
<td>15</td>
</tr>
<tr>
<td>4.03 TC</td>
<td>Pressure, Flow, Temperature and Level measurement</td>
<td>15</td>
</tr>
<tr>
<td>4.04 TN</td>
<td>Refractometry, Polarimetry</td>
<td>15</td>
</tr>
<tr>
<td>4.05 TN</td>
<td>Fuels and combustion</td>
<td>15</td>
</tr>
<tr>
<td>4.06 TN</td>
<td>Plant Automation</td>
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Part I: Chemical and Plant Engineering

4.01 TC: Principles of distillation
Principles of distillation Vapour liquid equilibrium, boiling point, and diagram. Basic principle of distillation, Pot and coffee stills conventional/ continuous distillation system. Introduction study of elementary chemical engineering concepts. Classification of chemical process. Material balance with and without chemical reaction, process calculation involving various unit operations.

Heat transfer fundamentals
Types of heat exchange, design of heat exchange equipments and their application to distillery industry.

4.02 TC: Utility requirements for typical distillery

Reference Books:
1. Introduction to Chemical Engineering – Badger and Baneo
2. Introduction to Chemical Engineering – Ghosal & Sanyal
3. Staichiometry – Bhatt and Vora

Part –II Instrumentation

4.03 TC: Pressure, flow, temperature and flow measurement
Introduction to Instrumentation, important terms associated with instruments such as range, span, accuracy, error, resolution, accuracy, reproducibility, repeatability, and sensitivity. Various pressure units and their conversion, pressure transducers such as barometer, manometers, Bourdon tube, diaphragm, bellows, capsule, strain gauges for pressure measurement.
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**Flow measurement**
Basic terms such as total flow, volumetric flow, Mass flow, types of flow, flow transducers such as orifice plate, pitot tube, flow nozzle, venturi meter, variable area flow meter, magnetic flowmeter, coriolis mass flow meter, vortex flowmeter, ultrasonic flowmeter, turbine flowmeter, displacement flowmeter.

**Temperature measurement**
Various scales and conversion, Introduction to filled system thermometers, expansion thermometers, thermocouples, Resistance temperature detector, Thermistors and pyrometers.

**Level measurement**
Direct methods such as gauge glass method, float method, magnetic level indicator, magnetic level switches, indirect methods such as hydrostatic method, radiation method, ultrasonic method and capacitance method.

4.04 **TN: Refractometry, polarimetry:**
Refractive index, Hand refractometer, Abbe’s refractometer.
PH and conductivity measurement - Introduction, different types of sensors, pH meter and conductivity meter.

**Polarimetry**
Laurentz polarimeter, industrial polarimeter, white lamp single wedge/double wedge polarimeter, automatic polarimeter.

4.05 **TN: Fuels and combustion:**

4.06 **TN: Plant Automation:**
Different systems used for automation. Details of PLC, SCADA and DCS monitoring systems. Benefits of automation.

**Reference Books:**
1. Instrument Engineers handbook – Process measurement by BG Liptak
2. Process Instrumentation & Control by A. P. Kulkarni
4. Instrumental methods of analysis by Willard, Merrit & Dean.
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WT 2.5 Practical- I

1. Sampling & grading of barley.
2. Preparation of sample of barley for chemical analysis.
3. Determination of Moisture & Extract content of barley.
4. Study of germination of barley.
5. Determination of Specific Gravity & Extract of wort.
7. Determination of Fermentable saccharides of wort.
9. Sampling & physical tests of malt.
10. Determination of moisture content of malt.
11. Determination of extract content of malt.
12. Determination of ethanol content of spirit sample by oxidation method.
14. Determination of total & fixed volatile acidity of rectified spirit (ISI method)
15. Determination of volatile acidity of rectified spirit (ISI method)
16. Determination of aldehyde content of Rectified Spirit (AOAC Method)
17. Determination of ester content of Rectified Spirit (AOAC Method)
18. Determination of fusel oil content in spirit sample.
19. Determination of furfural content in spirit sample.
20. To conduct potassium permanganate test for finding the quality of spirit.
22. Preparation of wine from grapes.
23. Determination of total reducing sugar of wine production.
24. Determination of pH & total acidity of wine.
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M. Sc. -II
Semester-III
WT 3.1 Alcohol Technology – II
Summary

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<tr>
<td>1.01 TC</td>
<td>Characteristics of various alcohols, denaturation and by-products of alcohol industry</td>
<td>15</td>
</tr>
<tr>
<td>1.02 TC</td>
<td>Manufacture of Extra Neutral Alcohol, Anhydrous alcohol/Fuel ethanol</td>
<td>15</td>
</tr>
<tr>
<td>1.03 TC</td>
<td>Reduction, blending and alcoholic beverages</td>
<td>15</td>
</tr>
<tr>
<td>1.04 TN</td>
<td>Analytical aspects of alcohol and alcoholic beverages. Overview of distillery industry in India and world</td>
<td>15</td>
</tr>
<tr>
<td>1.05 TN</td>
<td>Making of various traditional beverages</td>
<td>15</td>
</tr>
<tr>
<td>1.06 TN</td>
<td>Importance of thermotolerant and osmophilic yeast in alcohol industry</td>
<td>15</td>
</tr>
</tbody>
</table>

75+15=90

Note:
1) 3 TC Credits and any 2 Credits from TN.
2) The subject covers total 5 Credits i.e.
   Teaching clock hours = 60 clock hours and
3) Total clock hours per course = 75+15=90 clock hours

1.01 TC: Characteristics of various alcohols, denaturation and by-products of alcohol

1.02 TC: Manufacture of Extra Neutral Alcohol, Anhydrous alcohol/Fuel ethanol.

1.03 TC: Reduction, blending and alcoholic beverages.
Alcoholic beverages-Classification of beverages, liquor, country liquor manufacturing process. Quality control aspects. Global practices for manufacturing of IMFL. Maturation and aging: changes during maturation (spirit characters, aroma, flavor etc). Types of wood used for cask/barrel making. Typical design of barrel Role of excise in CL and IMFL. Shelf life of alcoholic beverages.
1.04 TN: Analytical aspects of alcohol and alcoholic beverages
Overview of IS and international standards of molasses, various alcohol and alcoholic beverages. Proper sampling of spirit samples for analysis. Introduction to important Global organizations in all over the world involved in analysis of spirit and beverages.

Overview of distillery industry in India and world

1.05 TN: Making of various traditional beverages
Introduction to making of grain based popular beverages in the world. Indian rice beer (Pachwai), Bhaati Jaanr, Chhang (Lugri, Jhol, Chakti, Ghanti), Themsing, Rakshi, Mingri, Lohpani, Bhangchang, Apong, Sekete, etc.

1.06 TN: Importance of thermotolerant and osmophilic yeast in alcohol industry
Basic mechanism of thermotolerant and osmophilic yeast, the factors determining and affecting stress of thermotolerance and osmophilic, Industrially important strains for alcohol fermentation and beneficial aspects to industry.

Reference Book:
2. Alcoholometry – Satyanarayana Rao
3. Handbook of Fermentation & Distillation – A.C. Chatterjee
4. Distillation – H.C. Barron
5. Technical Excise Manual
6. Byproducts of sugar industry – Paturao
WT 3.2 Brewing technology-II
Summary

<table>
<thead>
<tr>
<th>Credit No.</th>
<th>Credit title</th>
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<tr>
<td>2.01 TC</td>
<td>Yeast metabolism and brewhouse technology</td>
<td>15</td>
</tr>
<tr>
<td>2.02 TC</td>
<td>Control of brewing process</td>
<td>15</td>
</tr>
<tr>
<td>2.03 TC</td>
<td>Packaging and sanitation aspects in brewery</td>
<td>15</td>
</tr>
<tr>
<td>2.04 TN</td>
<td>Brewery by - products and waste valorization</td>
<td>15</td>
</tr>
<tr>
<td>2.05 TN</td>
<td>Quality management systems</td>
<td>15</td>
</tr>
<tr>
<td>2.06 TN</td>
<td>Malt analysis</td>
<td>15</td>
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<tr>
<td></td>
<td></td>
<td>75+15=90</td>
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</table>

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1) 3 TC Credits and any 2 Credits from TN.
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3) Total clock hours per course= 75+15=90 clock hours

2.01 TC: Yeast metabolism and brewhouse technology
M. Sc. (WBAT) Revised Syllabus

2.02 TC: Control of brewing process

Introduction, process performance, Brewhouse unit operations, Grist preparation
– Malt cleaning, Malt weighing, malt milling – Grist particle size distribution, Grist
storage, dust extraction and dust explosion prevention malt silo-level detection
and stock control, Grain flow and Routing, Mashing: Grist transfer, water flow &
temperature Mash homogeneity, mash heating, temperature control, vessel level
control, conversion efficiency, Wort separation: Mash transfer. Wort filtration,
sparging, effluent, spent grain, extract yield to kettle, Wort Boiling: Nucleate
Boiling Evaporation rate, Level control Avoidance of boil over, liquid adjunct
metering, Hops addition and utilization, volatile stripping, trub formation, Hot
wort clarification and cooling: Hot wort clarification wort cooling, wort flow rate,
wort temperature, turbidity and cold break, conductivity, wort oxygenation, trub
handling and wort recovery, Brewhouse yield.

Fermentation: Wort: - Clarification, Aeration laboratory analyze, Pitching –
Microbial examination, cell concentration and pitching, pitching process.
Metabolism & growth – biochemistry of fermentation, growth during
fermentation, measurement of growth. Batch fermentations, Lager fermentation,
fermentation vessels, characteristics of fermentation, Ale fermentation,
Laboratory analysis during fermentation, factors affecting fermentation, yeast
strain and condition, pitching rate and yeast growth, temperature, oxygen, zinc,
trub canny over, fermenter geometry, interrelationship, Related fermentations:
High gravity fermentations, accelerated fermentations, High-pressure
fermentations, Continuous fermentations, low caloric fermentation: Definition
production methods, Nonalcoholic and low alcohol fermentation – Definitions,
major deficiencies, production methods, Immobilized yeast, Abnormal
Fermentations – Symptoms causes – process variations, wort nutrient
deficiencies yeast changes. Treatments, Beer transfers and yeast separation –
yeast cropping consideration, method of cropping – centrifugation, Recovery of
carbon dioxide – purity and collection strategies.

Aging and Finishing: Introduction, Objectives of Aging and Finishing,
component processes flavor maturation: - Impart flavor compounds Diacetyl and
2, 3-pentanedione, sulfur compounds, non-volatile flavor maturation, yeast
autolysis Lagering and secondary fermentation (Kransening) Historical Lagering
Practice, Krausening, lagering without secondary fermentation, addition of
Clarification: - Gravity sedimentation, finings, filtration, filters, sterile filtration.
Stabilization: Beer Stability: Biological and Non-biological Instability. Biological
Instability, Non biological stability: Physical stability, Flavor stability foam
stability, Gushing, light stability, Flavor stability, Biological stability, Physical
stability, Carbonation: - Basics of beer carbonation, modern carbonation,
Standardization.

2.03 TC: Packaging and sanitation aspects in brewery

Packaging Technology: Levels of packaging, packaging materials, packaging and
brewing industry, cost of packaging, glass bottles and bottling, bottle filling, PET
bottles, cans, Kegs and Kegging, Pasteurization, Tunnel Pasteurization packaging
line efficiency. Introduction to CIP.
M. Sc. (WBAT) Revised Syllabus

Sanitation and Pest Control: Types of pest encountered, integration of sanitation and pest control methods, possible points of contamination, insects control methods, insect monitoring method, safety.

2.04 TN: Brewery by-products and waste valorization
Composition and feed value of major brewery by-products and competitive feeds, Brewhouse effluent, spent Hops and Trub. Wet Brewers Grain Handling and Dewatering, Brewers Grain Drying. Brewers grain Feed Products. Brewers yeast, Brewers condensed soluble, excess carbon dioxide, spent filter cake.

2.05 TN: Quality management systems
Quality management systems, ISO 9000, Hazard Analysis critical control point, customer requirements, material control, analytical control, customer and consumer feedback, process control.

2.06 TN: Malt analysis
System of analysis of malt, Common analysis – Hot water extract, cold water extract, Moisture content, Distatic power, Dextrinising units, Colour, Fermentable extract, Friability and homogeneity.

Reference Book:
**WT 3.3 Enology- II**

**Summary**

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<tbody>
<tr>
<td>3.01 TC</td>
<td>Role of various microbes in enology</td>
<td>15</td>
</tr>
<tr>
<td>3.02 TC</td>
<td>Rapid detection of microbial spoilage in wine process</td>
<td>15</td>
</tr>
<tr>
<td>3.03 TC</td>
<td>Sensory analysis and tasting of wine</td>
<td>15</td>
</tr>
<tr>
<td>3.04 TN</td>
<td>Marketing aspects of wine and brand development</td>
<td>15</td>
</tr>
<tr>
<td>3.05 TN</td>
<td>Packaging of wine and standards/guidelines/certification in wine manufacturing</td>
<td>15</td>
</tr>
<tr>
<td>3.06 TN</td>
<td>Concept of wine parks</td>
<td>15</td>
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**3.01 TC: Role of various microbes in enology**


**3.02 TC: Rapid detection of microbial spoilage in wine process**

Impedimetric techniques (Conductance, capacitance), Microcalorimetry, Turbidometry, Flow cytometry, Microcolony method, direct epifluorescence filter technique. Methods for the rapid identification of microorganisms. PCR, Wine spoilage- introduction; spoilage microorganism; Wine faults. Production technology of Wine from fruits other than the grapes, application of colour & additive in grape wine production.

**3.03 TC: Sensory analysis and tasting of wine**

Wine tasting- Smell of wine, taste & colour of wine, sensory analysis of wine. Factors affecting on sensory analysis. Sensory analysis profile of white, red and sparkling wine. Sensory analysis profile of day to day fermented young wines and comparison with old wines.

**3.04 TN: Marketing aspects of wine and brand development**
Ideal packaging of wine bottle, The question of age, the private wine cellar, serving temperature, decanting wines, which glass for which wine, serving wine, how to open & serve sparkling wines, Corkscrews.

3.05 TN: Packaging of wine and standards/guidelines/certification in wine manufacturing
Principles and methodology involved in analytical techniques of wine analysis, Application of various analytical instruments used in wine analysis.
Definition of quality, quality assurance, importance of quality control & assurance, role of quality control department in wineries, Different factors affecting the wine quality, quality criterion of different wines etc.
Standards of various types of wine and safety management system for winery. Different rules, regulation and laws for wine and wine manufacturing/ wineries. (GLP, PFA, BIS, CODEX standards, JECFA, HACCP, ISO, Global/European guidelines, Food Safety and Standards Act, 2006 etc.).
Recent developments in wine packaging and government regulations in various countries. Packging technology, labeling & storage of wines; Economics aspects of packaging-economic feasibility studies of wine packaging.

3.06 TN: Concept of wine parks
Concept of wine parks recent developments. Wine parks & nodal agencies for establishment of Wine Park in India. Status of wine parks in India with reference to case study. Important wine zones in India.

Reference Book:
4. Introduction to Winemaking, Viticulture and Enology 3- Prof. Ralph E. Kunkee.
5. Understanding wine- Course notes- Patrick Iland, Peter Gago.
10. Monitoring the wine making process from grapes to win techniques and concepts- Patrick ILAND, Nick BRUER, Andrew EWART, Andrew MARKIDES, John SITTERS.
12. Wine technology marketing- Mary Cole.
WT 3.4 Chemical & Plant engineering –II
Summary

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<tr>
<td>3.01 TC</td>
<td>Mass balance and Separation techniques</td>
<td>15</td>
</tr>
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<td>3.02 TC</td>
<td>Heat transfer</td>
<td>15</td>
</tr>
<tr>
<td>3.03 TC</td>
<td>Thermodynamics</td>
<td>15</td>
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<tr>
<td>3.04 TC</td>
<td>Fluid mechanics</td>
<td>15</td>
</tr>
<tr>
<td>3.05 TN</td>
<td>Psychometric</td>
<td>15</td>
</tr>
<tr>
<td>3.06 TN</td>
<td>Design of distillation column</td>
<td>15</td>
</tr>
</tbody>
</table>

Note:
1) 3 TC Credits and any 2 Credits from TN.
2) The subject covers total 5 Credits i.e. Teaching clock hours = 60 clock hours and
3) Total clock hours per course= 75+15=90 clock hours

3.01 TC: Mass balance and Separation techniques
Single and multiple unit processes, Reactive systems, Purge systems, Recycle, Bypass systems.
Separation techniques like sedimentation, filtration & centrifugation: basic principles & equipments. Membrane separations & their applications.

3.02 TC: Heat transfer

3.03 TC: Thermodynamics
Gases and their properties, Vapor pressure, Gibbs phase rule, Ideal gas law, Equation of state compressibility factor, Energy balances specific and latent heat, Enthalpy, Entropy, Internal energy heat and work, Open and closed systems, Thermodynamic diagrams, power and refrigeration.

3.04 TN: Fluid mechanics
Fluid static, fluid dynamics, flow measurement, pipe/duct flow. Frictional pressure losses in pipe/duct, flow pumps/fans, cavitations, net pressure, suction head, Flow of fluid in pipes, and through pump in brewery setting.

3.05 TN: Psychometric
Heating, cooling, humidification, dehumidification, mixing of air streams, drying of cereals and food as psychometric process.

3.06 TN: Design of distillation column
Calculation of number of plates using McCabe Thoiale method. Design of distillation column.
M. Sc. (WBAT) Revised Syllabus

Reference Books:
1. Introduction to Chemical Engineering – Badger and Baneo
2. Introduction to Chemical Engineering – Ghosal & Sanyal
3. Staichiometry – Bhatt and Vora
4. Process control systems by F.G. Shinskey
M. Sc. (WBAT) Revised Syllabus

WT 3.5 Practical

1. Determination of residue on evaporation of whisky sample.
2. To carry out distillation of whisky sample.
3. Determination of ethyl alcohol content of whisky by specific gravity method.
4. Determination of Total acidity as acetic acid of whisky.
5. To determine the volatile acidity whisky sample.
6. Determination of Aldehyde (as CH_3CHO) content of spirit (AOAC method).
7. Determination of Ester (as CH_3COO C_2H_5) content whisky.
8. Fusel oil determination in spirit sample.
10. Determination of Methyl Alcohol (as CH_3OH) content of whisky.
11. Reduction of the spirit.
12. Blending of spirit.
13. Preparation of sample of barley for chemical analysis.
14. To determine moisture content of the barley.
15. To determine the extract content of barley.
17. Analysis of alcohol by Gas Chromatography (Demonstration experiment).
18. Determination of starch content in grain flour sample.
19. Alcohol production from corn/sorghum/sweet potato (Demonstration experiment).
20. Estimation of hop bitterness and colour of beer.
Semester-IV
WT 4.1 Business Management: (BM)

Summary:

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<tr>
<th>Credit No.</th>
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<th>Total hours per credit</th>
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<tbody>
<tr>
<td>1.01 TC</td>
<td>Financial management and Financial analysis</td>
<td>15</td>
</tr>
<tr>
<td>1.02 TC</td>
<td>Financial control &amp; management information system</td>
<td>15</td>
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<tr>
<td>1.03 TC</td>
<td>Cost accountancy and working capital management</td>
<td>15</td>
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<tr>
<td>1.04 TN</td>
<td>Analysis of financial parameters for setting up of industry &amp; its appraisal report</td>
<td>15</td>
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<tr>
<td>1.05 TN</td>
<td>Maintenance Management, Inventory planning and Inspection</td>
<td>15</td>
</tr>
<tr>
<td>1.06 TN</td>
<td>Value engineering, production, planning and control</td>
<td>15</td>
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2) The subject covers total 5 Credits i.e.
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   Total clock hours per course = 75+15=90 clock hours

1.01 TC: Financial management and Financial analysis
Definition, objectives, functions & scope. Details of financial analysis and management.

1.02 TC: Financial control & management information system
Definition, objectives, functions & scope. Funds flow analysis, Ratio analysis, Cost profit volume analysis.

1.03 TC: Cost accountancy and working capital management
Concept, dimensions and operating cycle of business.

1.04 TN: Analysis of financial parameters for setting up of industry & its appraisal report.

1.05 TN: Maintenance Management, Inventory planning and Inspection
Importance and types of maintenance, spare part maintenance and concept of TPM. Inventory planning and control, E.O.Q and numerical on E.O.Q.
Inspection: Cent percent Inspection, Random Sampling, Introduction to Six Sigma, Seven tools of quality control.

1.06 TN: Value engineering, production, planning and control
Concept of value engineering and value analysis, how to reduce the cost of production. Production Planning and Control (PPC).
### WT 4.2 Industrial Waste Treatment & Environmental Management

#### Summary

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<tr>
<td>2.01 TC</td>
<td>Waste generation &amp; characteristics of effluent</td>
<td>15</td>
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<tr>
<td>2.02 TC</td>
<td>Biological treatment fundamentals</td>
<td>15</td>
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<tr>
<td>2.03 TC</td>
<td>Winery and brewery sanitization and waste disposal regulations</td>
<td>15</td>
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<tr>
<td>2.04 TN</td>
<td>Waste water disposal systems in industries</td>
<td>15</td>
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<tr>
<td>2.05 TN</td>
<td>Water conservation in distilleries</td>
<td>15</td>
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<tr>
<td>2.06 TN</td>
<td>Air pollution</td>
<td>15</td>
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</table>

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2) The subject covers total 5 Credits i.e.

- Teaching clock hours = 60 clock hours and
- Total clock hours per course = 75+15=90 clock hours

2.01 TC: Waste generation & characteristics of effluent. IS norms.

2.02 TC: Biological treatment fundamentals
- Energy generation and types of anaerobic system, Incineration – Theoretical, considerations, types, incineration systems in practice, Type of secondary treatment system.

2.03 TC: Winery and brewery sanitization and waste disposal regulations

2.04 TN: Waste water disposal systems in industries
- Waste Beer, solid waste materials, wastewater disposal and treatments. Sludge treatment, Disposal and Utilization, Land application of Brewery Effluents, Production of single cell protein from Brewery Effluents.

2.05 TN: Water conservation in distilleries.
- Requirement of total water for process and non-process in typical 30 KLPD molasses based distillery. Scope for water recyclies of various streams for process.
- Cost economics of saving of water in distillery with typical case study. Importance of water conservation in distilleries.

2.06 TN: Air pollution:
M. Sc. (WBAT) Revised Syllabus

Air pollution control principles & equipments, Environmental Audit, Disposal of effluent & soil fertility, Environmental laws, Case studies.

Reference Books:

1. T.D. Brock, Biology of Microorganisms.
WT 4.3 Alcohol Technology-III
Summary

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<th>Credit No.</th>
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<td>3.01 TC</td>
<td>Fed batch/Continuous fermentation</td>
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<tr>
<td>3.02 TC</td>
<td>Alcohol from Non-molasses sources and manufacture of malt alcohol and cost of production of alcohol</td>
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<tr>
<td>3.03 TC</td>
<td>Multipressure distillation and Molecular sieve dehydration system.</td>
<td>15</td>
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<tr>
<td>3.04 TN</td>
<td>Importance of Spectroscopic and chromatographic techniques in alcohol industries</td>
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<tr>
<td>3.05 TN</td>
<td>Alcohol production from sugar processing intermediates</td>
<td>15</td>
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<tr>
<td>3.06 TN</td>
<td>Section wise material balance of typical molasses based distillery</td>
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</table>

Note:
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2) The subject covers total 5 Credits i.e. Teaching clock hours = 60 clock hours and Total clock hours per course = 75+15=90 clock hours

3.01 TC: Fed batch/Continuous fermentation

3.02 TC: Alcohol from Non-molasses sources and manufacture of malt alcohol and cost of production of alcohol
Characterization of various non-molasses sources for alcohol production. Process details of alcohol production from Corn, Sweet Sorghum, Tapioca , Sugarcane Juice and others, Quality aspects of alcohol from non-molasses sources, Production of alcohol from non-molasses sources in the existing molasses based distillery. Manufacture of liquors-Rum, Whisky, Gin, Vodka, brandy, Cachaca, Taquilla etc. & bottling, packing of liquors. Reduction & blending of spirit. Blending and sensory analysis of various spirit and liquors. Details of production of malt alcohol.
M. Sc. (WBAT) Revised Syllabus

International scenario of alcohol production and potential for import and export. Typical cost of production of alcohol.

3.03 TC: Multipressure distillation and Molecular sieve dehydration system.
Mechanism, flow diagram and concepts behind Molecular sieve and MPR distillation. The quality aspects of spirit using MPR distillation.

3.04 TN: Importance of Spectroscopic and chromatographic techniques in alcohol industries
Introduction to various spectroscopic and chromatographic techniques useful for alcohol industry. Role of GC-MS, GC, HPLC, HPTLC and other sophisticated instruments in analysis of molasses, fermented wash, RS, ENA, AA, SDS, beer, wine and various beverages.

3.05 TN: Alcohol production from sugar processing intermediates.
Details of sugar processing intermediates, Details of sugarcane juice to ethanol fermentation, Use of B-Heavy molasses for alcohol production, Ethanol blending programme in Brazil and beneficial aspects to industries.

3.06 TN: Section wise material balance of typical molasses based distillery
Material balance of batch and continuous fermentation; Atmospheric and multipressure distillation, Azeotropic and Molecular sieve dehydration system.

Reference Book:
2. Alcoholometry – Satyanarayana Rao
3. Handbook of Fermentation & Distillation – A.C. Chatterjee
4. Distillation – H.C. Barron
5. Technical Excise Manual
6. Byproducts of sugar industry – Paturao
WT 4.41 - Second Generation Biofuels

Summary

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<td>4.01 TC</td>
<td>Pre-treatments and biochemical routes for hydrolysis of lignocellulosics.</td>
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</tr>
<tr>
<td>4.02 TC</td>
<td>Thermochemical route and syngas production</td>
<td>15</td>
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<tr>
<td>4.03 TC</td>
<td>Value added products Syngas, Bio-butanol/bio-ethanol production.</td>
<td>15</td>
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<tr>
<td>4.04 TN</td>
<td>Microbial genetic/metabolic engineering</td>
<td>15</td>
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<tr>
<td>4.05 TN</td>
<td>Algal biofuels</td>
<td>15</td>
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<tr>
<td>4.06 TN</td>
<td>Bio-oil by Rapid thermal pyrolysis</td>
<td>15</td>
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4.01 TC: Pre-treatments and biochemical routes for hydrolysis of lignocellulosics.
Introduction to 1st Generation and 2nd Generation biofuels. Cellulose: What is cellulose? Chemistry of cellulose; Characteristics of cellulose; Details of cellulose, hemicellulose and lignin. Why cellulose is difficult to be broken down? Composition and significance of bagasse, trash and rice straw. Pretreatment of cellulose: 7-8 methods and yield of sugars. How lignin is separated by pretreatment? Uses of lignin. Enzymatic and acid hydrolysis-Advantages and disadvantages. Why enzymatic hydrolysis is more important as compared to acid hydrolysis?

4.02 TC: Thermochemical route and syngas production
Details of cellulose to syngas production.

4.03 TC: Value added products Syngas, Bio-butanol/bio-ethanol production.
Introduction to syngas to other biofuels. List of various biofuels obtained from syngas and its economic importance and current scenario. Microorganisms involved in butanol fermentation, Various substrates for production of butanol, Mechanism and biochemistry behind butanol fermentation, Physical, chemical, engineering and downstream processing aspects involved in butanol fermentation, Calorific value as compared to other fuels.

4.03 TN: Microbial genetic/metabolic engineering
Various terminologies used in genetic engineering, Basic aspects of genetic material, various techniques for transfer of genetic material.

4.05 TN: Algal biofuels
Need for algae as alternative feedstock for biofuel generation (Demand, supply and challenges with present generation biofuels). Algae as next generation/potential source of bioethanol and other bio-based chemicals.
M. Sc. (WBAT) Revised Syllabus


4.06 TN: Bio-oil by Rapid thermal pyrolysis
Introduction to bio-oil, Production of bio-oil, Properties of bio-oil-Chemical, physical and environmental aspects of bio-oil, uses of bio-oil, Techniques for fast pyrolysis of biomass.

Reference Books -
4. Microbial Technologies in Advanced Biofuels Production, (Ed), Patrick C. Hallenbeck, Springer Publication
4.01 TC: Beer types and their special features

Beers produced by top & bottom fermentation, Special features of top fermentation, Physiological differences between top fermenting yeast & Bottom fermenting yeast. Assessing yeast viability, Yeast viability tests, Yeast vitality test. Measures of cellular activity, Fluorometric vitality test, Saccharomyces wild yeast, Non Saccharomyces Wild yeasts, Biofilms, Controlling contamination.

4.02 TC: Fermentation management

Wort collection, wort cooling & Clarification, Wort Oxygenation, Control of yeast Pitching rate, Direct Weight of yeast cake, Addition of yeast Slurry Cone- Cone Pitching, use of infrared turbidometry Monitoring, Fermentation Progress, Wort gravity Co2 evolution, PH, rate of O2 assimilation yeast, growth, Ethanol formation Vicinal dike tone Concentration, Effects of process Variables on fermentation Performance, Primary contaminants, Factors influencing abnormal fermentation. Inoculums Preparation & Strain Improvement- Primary Screening, Secondary Screening, Mutation, Natural mutations Artificial induction of mutation, selection of high Producers, Revert mutants. Genetic Engineering of yeast.

4.03 TC: Bottling/canning the beer

M. Sc. (WBAT) Revised Syllabus

4.04 TN: Micro/Pub brewing

4.05 TN: Cereal harvesting & storage, Malt House practices.

4.06 TN: Energy Management in the breweries

Reference Book:
M. Sc. (WBAT) Revised Syllabus

(WT 4.43) Advance Enology

Summary

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<tr>
<td>4.01 TC</td>
<td>Principal constituents of grapes and must</td>
<td>15</td>
</tr>
<tr>
<td>4.02 TC</td>
<td>Control measures during fermentation</td>
<td>15</td>
</tr>
<tr>
<td>4.03 TC</td>
<td>Principal components of wine</td>
<td>15</td>
</tr>
<tr>
<td>4.04 TN</td>
<td>Maturation and aging of wine</td>
<td>15</td>
</tr>
<tr>
<td>4.05 TN</td>
<td>Blending and bottling of wine</td>
<td>15</td>
</tr>
<tr>
<td>4.06 TN</td>
<td>Wine faults and spoilage</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td></td>
<td>75+15=90</td>
</tr>
</tbody>
</table>

Note:

1) 3 TC Credits and any 2 Credits from TN.
2) The subject covers total 5 Credits i.e.
   Teaching clock hours = 60 clock hours and Total clock hours per course = 75+15=90 clock hours

4.01 TC: Principal constituents of grapes and must.

4.02 TC: Control measures during fermentation
Cultured yeast, Control of temp, Monitoring, Stopping the Fermentation & A stuck Fermentation Naturally sweet wines. Malolactic fermentation, Cool fermentation, Skin contact, sur lie Battonage, Prevention of Oxidation, fermentation in barrel Tumultuous fermentation. Maturation in wood.

4.03 TC: Principal components of wine

4.04 TN: Maturation and aging of wine
M. Sc. (WBAT) Revised Syllabus

4.05 TN: Blending and bottling of wine


4.06 TN: Wine Faults and spoilage


Reference Book-
1. The Production of Grapes & Wine in cool Climates. David Jackson & Danny Schuster
4. Understanding Wine Technology-David Bird
5. Practical aspects of Wine Filtration-Bernard Gautier.
8. Wine for Women-Leone Sbrocco.
10. American Society for Enology & Viticulture-Seattle
13. Understanding Wine Course Notes Patric II & Peter Gago
14. Wine Science- Ron S. Jackson
17. Wine Making From Grape growing to Market Place Richard P. Vine, Elien Harkness. Salley J. Linton
19. Wine Appreciation-Richard P. Vine
M. Sc. (WBAT) Revised Syllabus

(WT. 4.5) Short term research project (Individual/groups) OR  In plant training in industry.

The Opportunity to analyze a particular industry based problem or topic in depth. Conduct a relevant lab or library-based study. To provide a chance to improve fundamental research & analysis, skills & advance understanding of then processes involved in Wine technology, Brewing technology or Alcohol technology. Student has to undertake an extended investigation in an advanced topic of relevance to their degree discipline or to their Sponsoring industrial partner. The research project builds on the taught modules of the course. Students should analyses their results & present the same in the form of a dissertation that includes a review of previous research & set their work in context with critically argued discussion. Students should contribute via seminars or posters or publication to the research activity of the host/work institution.